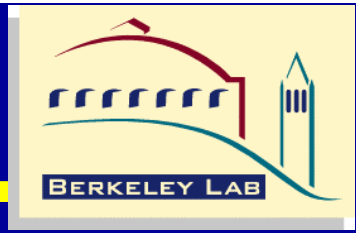

Discussion of Reliable Multicast Progress for the Continuous Data Protocol

Deborah Agarwal

Note: Much of the work described in this presentation has been conducted by SAIC and Telcordia personnel. The views expressed in this presentation are the author's and not necessarily those of the United States Government

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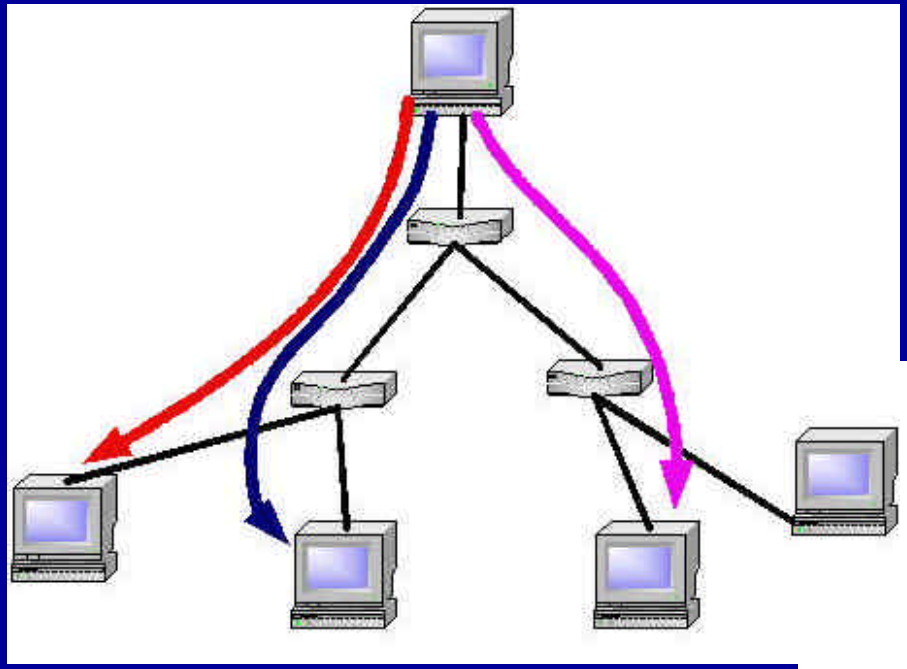
CD-x Multicast Experiments

- Objectives of CD-x Multicast Experiments
  - Evaluate the use of multicasting technology for continuous data collection and distribution
- Technical plan
  - GCI feasibility tests
  - Small-scale technical feasibility trial with CD-1
  - Test robustness of reliable multicast protocols
  - Study implementation for CD-1.1
  - Implement multicast enabled CD-1.1

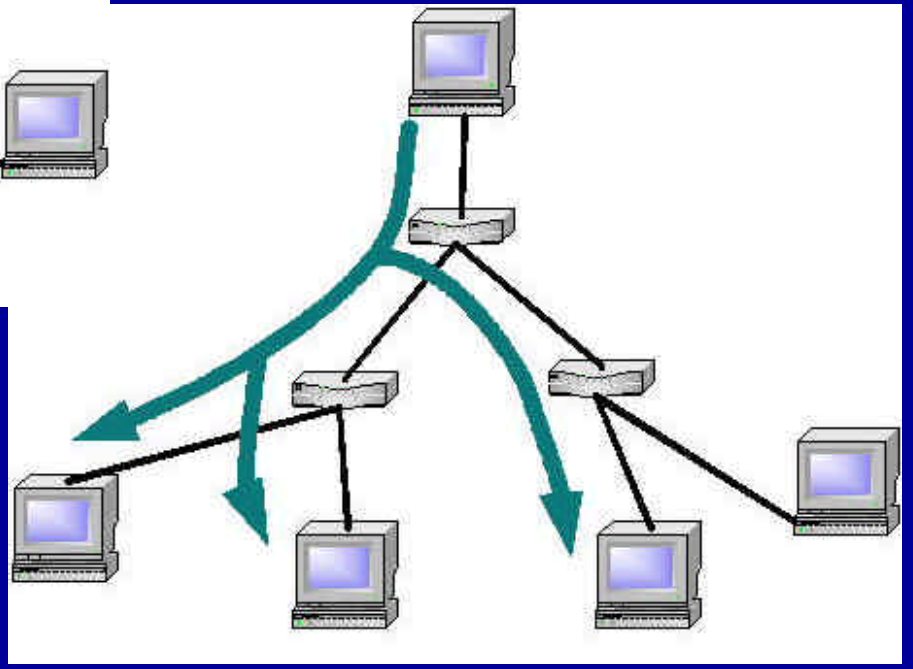
Multicast Communication

- Group communication mechanism
  - provides one-to-many and many-to-many communication
- Efficient dissemination of messages
  - network-based duplication (when needed)
  - local retransmissions
  - bandwidth savings
  - parallel delivery at multiple locations

IP Multicast Communication



Unicast

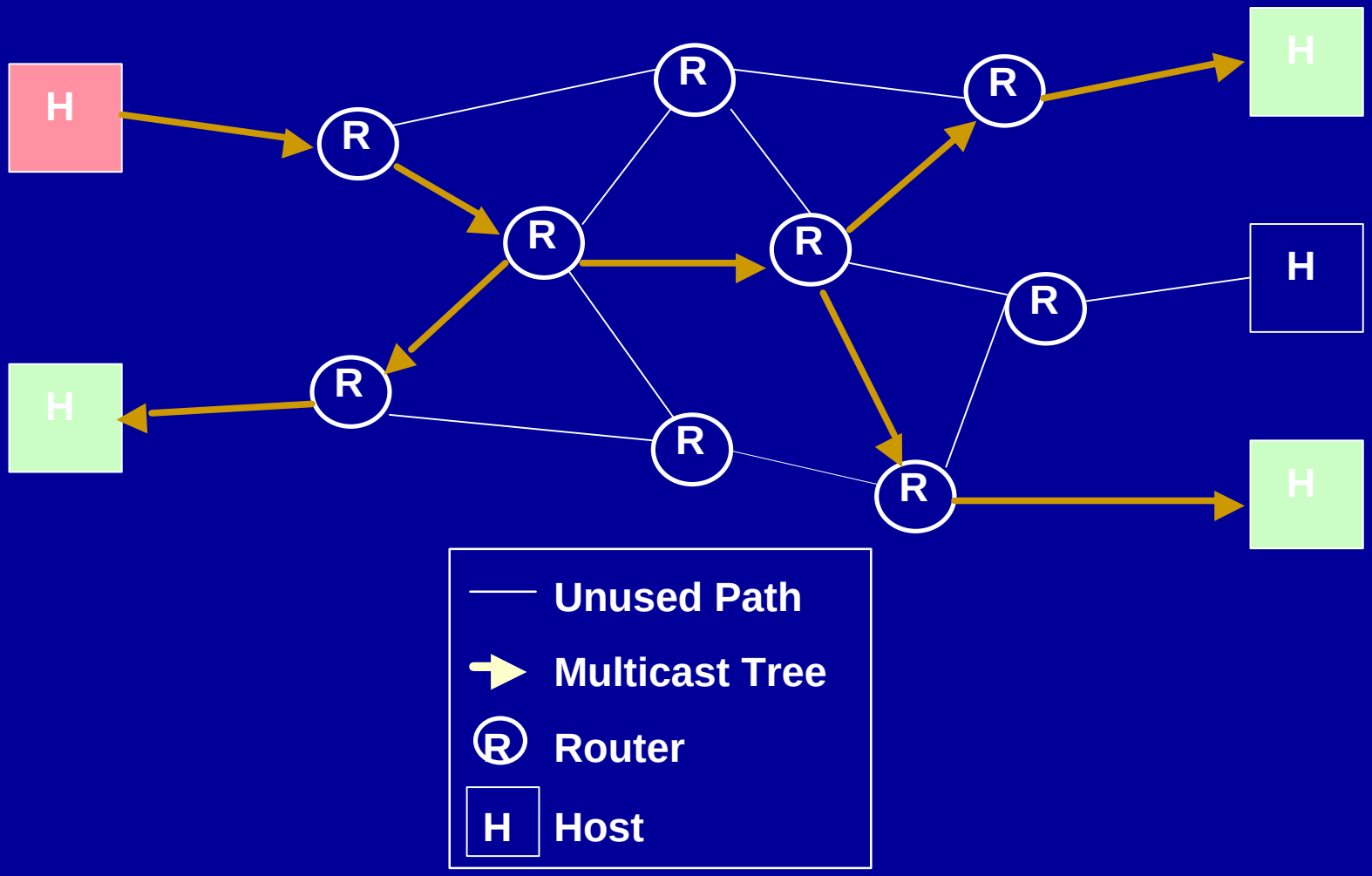


Multicast

Internet Protocol (IP) Multicast

- Efficient group communication mechanism
  - Send a message to a group of receivers
  - Best-effort delivery to the group members
- Implemented in the routers and hosts
  - Class D addresses used for multicast (224.x.x.x - 239.x.x.x)
  - Network components manage routing and duplicate the message as needed
  - Co-exists with TCP and UDP communication mechanisms
  - Source-Specific Multicast (SSM) – allows subscription to a single source/address pair

IP Multicast



Reliable Multicast

- Properties similar to TCP or weaker
- Application-level program
- Uses IP Multicast as the underlying communication mechanism
- Reliable and ordered delivery of messages within a group
- Tracks group membership
- Orders messages
- IETF Reliable Multicast Transport Working Group is defining standardized building blocks

GCI Feasibility Tests

- IP Multicast
  - Enabled in the GCI Integration Laboratory
  - Tested capabilities
- Reliable Multicast
  - Multicast Dissemination Protocol (MDP) installed in the GCI Integration Laboratory
    - ran with no modifications
    - transferred JPEG images remote to IDC and IDC to 2 remotes

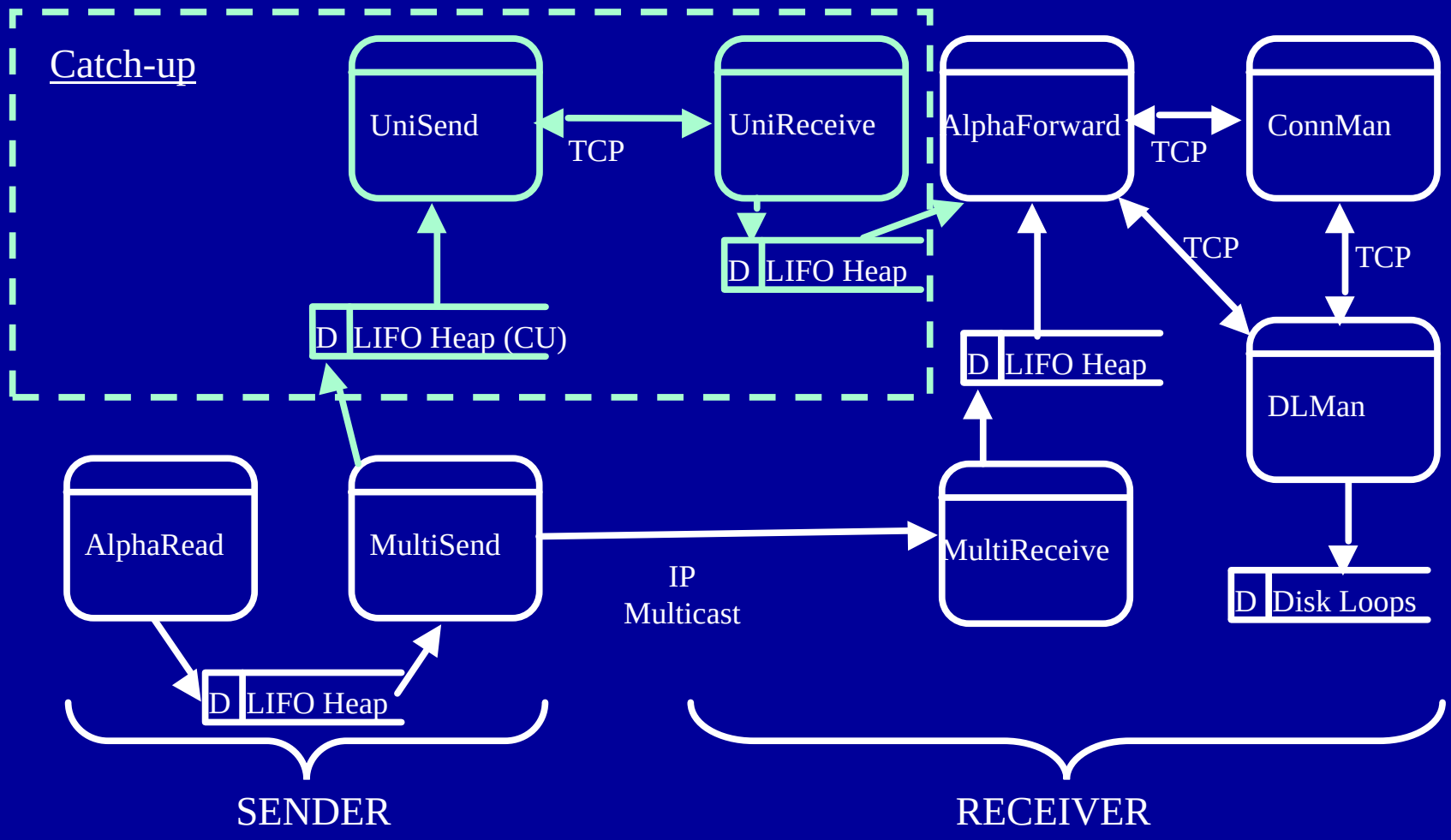
CD-1 Continuous Data Protocol

- Original protocol in use within the GCI
- Provides transmission of raw data from a source to a single receiver
- Based on unicast communication
- Responsible for forwarding data to subscribers
- When connection is down, data is buffered for later transmission

Multicast Modifications to CD-1

- Replicated LIFO Heap at the receiver (originally only at sender)
- Multicast components transfer frames between LIFO Heaps
  - MultiSend - sends frames from the sender's LIFO Heap
  - MultiReceive - receives frames at the receiver and places them in the LIFO Heap
- Original CD-1 code writes and reads the LIFO Heap
- RMTP-II protocol provides multicast frame transport protocol

Multicast-enabled CD-1 With Catch-Up Capabilities



Test Results

- Tests between Telcordia and CMR run continuously
  - Receiver unreachable several times
  - Correct catch-up operation when receiver became reachable
  - Correct merging of catch-up and multicast data
- Emulation of satellite environment with parameters consistent with results of GCI Integration Laboratory IP Multicast tests
- Tests of all start-up and recovery/catch-up capabilities performed

Discussion of CD-1.1

- CD-1.1 Contains retransmission request mechanisms
  - Allows recovery of data after re-establishment of a connection
- Connection setup frame provides a field that can be used to specify a multicast address
- Data frames are the unit of communication
  - self-describing (contains format information)
  - size depends on number of sensors, time duration, etc.
- Currently considering a custom reliable multicast solution that will leverage off of the CD-1.1 features

Multicast Alternative to Data Forwarding

- Data forwarding
  - + Minimal changes to sender and receiver
  - – Complex software and hardware required at forwarding site
  - – Delivery delayed by forwarding
- Multicast
  - – Sender and receiver need to run multicast enabled software
  - + Efficient use of network bandwidth
  - + IP multicast enabled in routers
  - + Delivery at multiple sites in parallel
  - – Firewall configuration

Conclusion

- Prototype implementation of multicast-enabled CD-1 completed and tested
- Basic feasibility experiments conducted in the GCI
- Evaluating reliable multicast protocols for use with CD-1.1
  - Currently favoring a custom solution
- Currently studying CD-1.1 for design of reliable multicast capabilities